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USE OF THE CAMERA IN STUDYING THE GROWTH AND DEVELOPMENT OF DAIRY ANIMALS

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Photography has come into daily use as a means of educating and entertaining mankind. Aside from the cinema, which has a place in the lives of most human beings, photography functions ceaselessly through the press and countless publications to carry visual news and records of events to millions. Even the illiterate are able to follow the course of events shown in pictures. History of to-day and of the past decade is recorded by the aid of the camera in a manner more nearly complete and more easily understood than was possible before the development of photography. The camera is finding a constantly widening field, and its application to scientific studies is proving that photography is a useful tool for those who are seeking to unravel nature's secrets.

A plan which has been carefully and systematically worked out for photographing dairy animals in the herd of the Bureau of Dairying at Beltsville, Md., is of great assistance and value in the dairy-cattle breeding investigations which are being conducted in that herd. It was realized very early that if the pictures were to be of the greatest value they should be as nearly as possible on the same scale, of a uniform position, and taken at regular intervals. In addition, a careful record of the dates must be kept in order to affix a correct legend to each picture.

The plan was put into practice in July, 1922, after a series of tests of various methods of taking pictures extending over several years. The photographing of all animals was begun soon after the starting of the breeding projects in 1918. The plan has been modi-

fied since 1922 by some changes in the length of the time interval between pictures, and also by the adoption of the cross-ruled background for use with animals up to the age of 1 year. None of these modifications have interfered with the original principles adopted, as no change was made in the camera. The pictures obtained by this system are a surprisingly prolific source of information, which could hardly be preserved by any other method of record keeping; and they afford an indisputable story of the development and appearance of the animals from calfhood to maturity. It is easy to see the value of such a record in a breeding test where comparable information is gathered in each succeeding generation.

The purpose of this circular is to describe the photographic equipment and methods used by the Bureau of Dairying in this study of the growth and development of animals, for the information of those

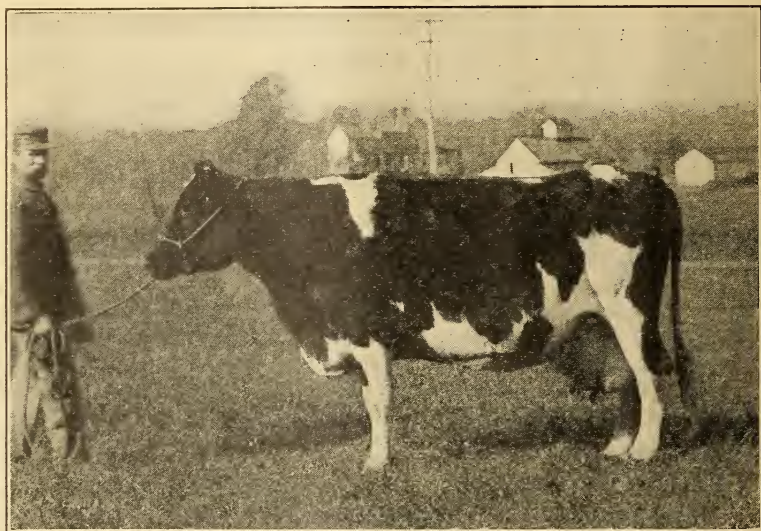


FIG. 1.—Poor background. Farm buildings and telephone pole along back of the animal and human figure detract from the subject

interested in similar studies. It is not a treatise on the technique of photography, but shows the possibilities of using the camera in such work.

BACKGROUNDS

One of the first considerations in planning photographic work with animal subjects is to give thorough study to the choice of background. The natural environment for dairy animals is a pasture or open field. Because the surroundings are not unusual, there is nothing to distract the eye from the subject, and the attention is confined to the animal; whereas pictures of cows taken in unnatural surroundings lead the mind astray and into speculation as to the place where the picture was taken, and into subconscious effort to identify surrounding objects, such as farm buildings, partly visible signs, or other unusual things showing distinctly in the background.

Animals placed directly before buildings are at a disadvantage because the sharp lines and clean-cut angles of the building afford a

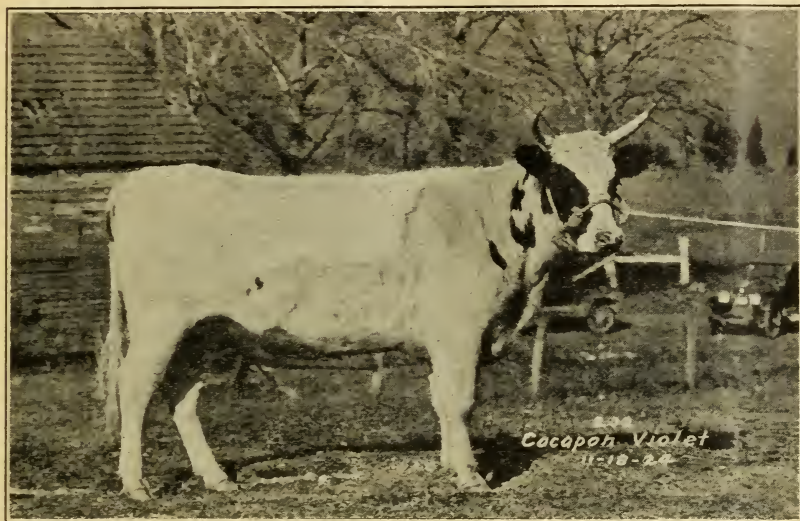


FIG. 2.—Poor background. Objects in the background are too conspicuous and too various

contrast to the more rounded outlines of the living thing. Reflections from windows, clearly marked shadows, and distinct structural

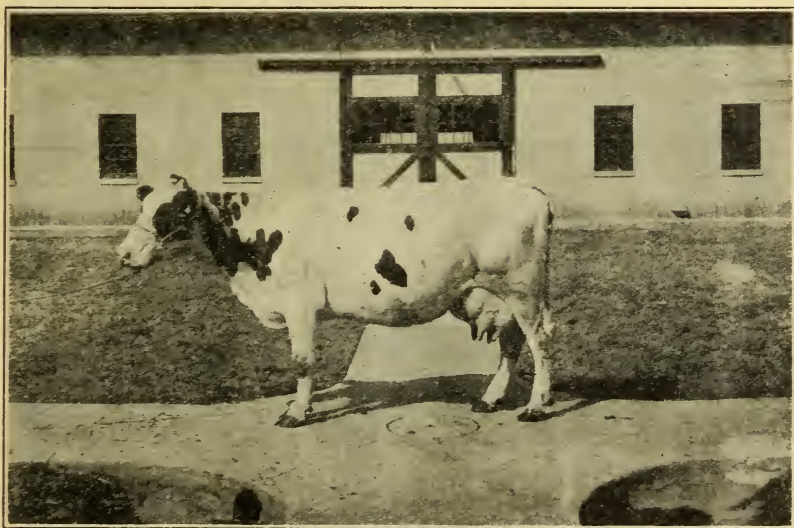


FIG. 3.—Background has too many straight lines and sharp angles. The contrast with the lines of the animal is too marked

details are undesirable and divert the attention from the subject; even a blank-wall background places the animal in artificial surroundings.

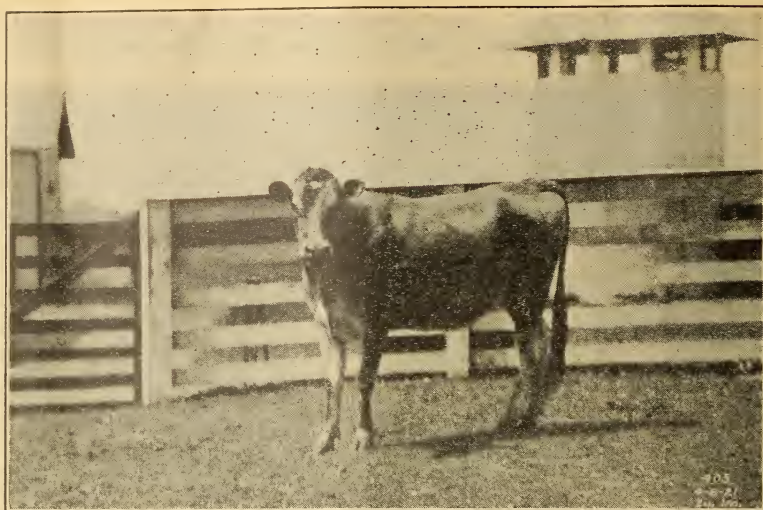


FIG. 4.—Poor background and position. The fence is too close to the subject and the straight top rail and position of animal accentuate the low back of the animal. The position is a poor one for comparative picture study

These points are illustrated in the first group of pictures shown (figs. 1, 2, 3, 4, and 5).

In selecting the field, pasture, or other open space in which to carry on the work, it is well to consider the presence of any un-

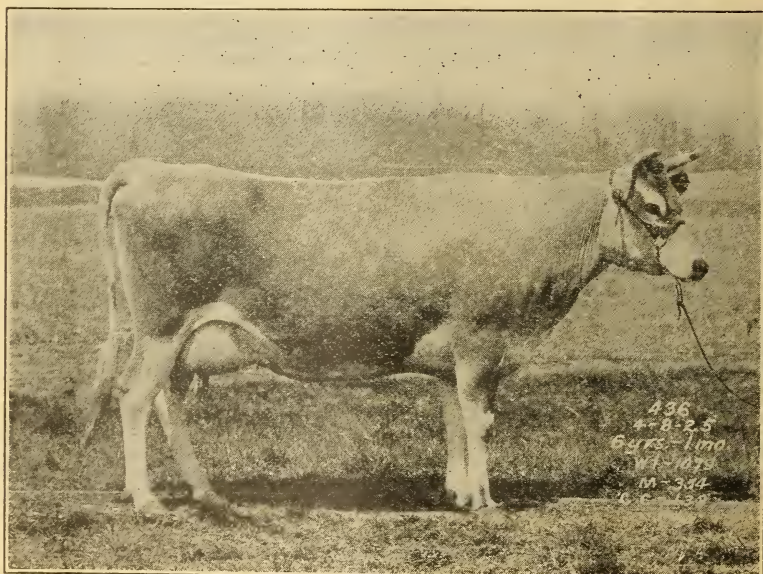


FIG. 5.—Good background. The animal is in natural surroundings and the background is free from conspicuous objects

slightly or conspicuous objects which might come within range of the camera. Rows of telephone poles, such as are placed along



FIG. 6.—Showing effect of row of telephone poles along back of animal

roadsides, and lines of fence posts or trees, groups of buildings, or single trees, are always undesirable in the background, especially

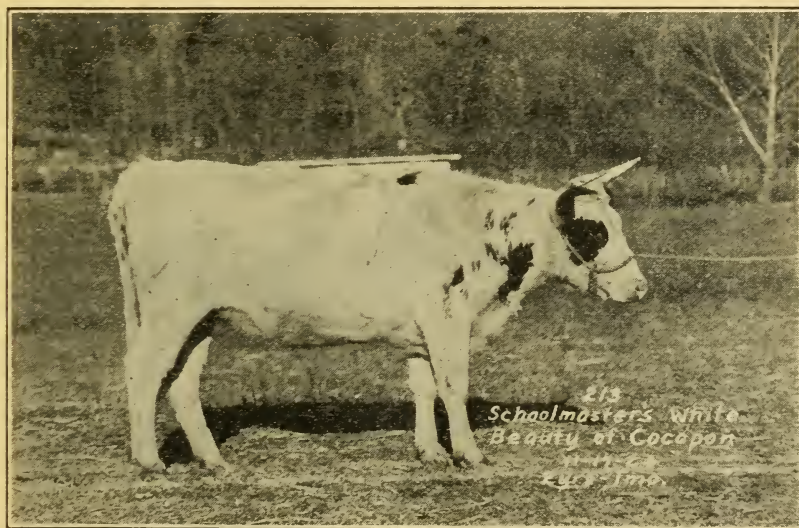


FIG. 7.—Roof of the small building in background makes top line of the animal indistinct

when they appear in the picture along the top line of the animal. Old rail fences may be romantic, but they add nothing desirable to the photograph of a cow.

When the amount of work is limited and can be done in an hour or two, it is only necessary to consider a limited stretch of



FIG. 8.—The old rail fence in background detracts from the subject

background; but if the work is carried on throughout the day, a wider range of space must be examined, as it is necessary to



FIG. 9.—White animal photographed against clear sky. Top line is very indistinct

change the direction in which the camera is pointed in order to get sunlight on the broad side of the subject. In some cases this would



FIG. 10.—Indefinite top line against sky. Human figure in the picture detracts from the subject. Position on side hill is bad

mean that with the camera as a center, an arc equal to 90° or more of the circumference of a circle would be necessary in order to meet the requirements for good background.



FIG. 11.—Clearly marked white top line against suitable background

The sky line is another consideration in choice of backgrounds. Animals having white along the top will not photograph well against a clear sky. The white of the animal and the blue of the

sky are indistinguishable, and it is often difficult to determine the exact top line of a cow under such circumstances. A gray sky has the same effect. When the site is located on rolling ground, this difficulty is overcome by locating the camera so that the rise of the ground is sufficient to carry the horizon above the back of the subject.

The second group of pictures shows both clear and indistinct top lines, and poor backgrounds. (Figs. 6, 7, 8, 9, 10, and 11.)

For the work at Beltsville, an open field, which is free of trees except in the far background, has been selected. Towards the north, northeast, and northwest, the ground rises sufficiently to throw the sky line above the tops of the animals.

PHOTOGRAPHIC EQUIPMENT

After some experimenting, a picture 5 by 7 inches in size was decided to be the most desirable, as that suffices to show the whole animal with a minimum waste of space, and gives sufficient detail, even with small individuals. A lens was then obtained which would

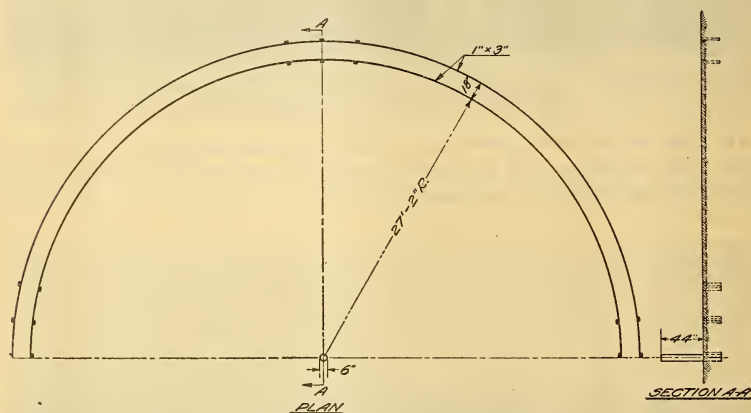


FIG. 12.—Plans showing location of camera and track for photographing animals

produce 5 by 7 inch pictures of satisfactory quality. It is one of the lenses of a $9\frac{1}{2}$ -inch symmetrical double combination, and when used in this manner has a focal length of 19 inches. With this lens the largest animals, when placed approximately 27 feet from the camera, will fill the 5 by 7 inch plate comfortably. The camera has a collapsible bellows, which has been boxed in, making the outfit rigid, so as to prevent any adjustment in the length of the bellows after careful focusing had established the optimum working distance. The long distance from camera to subject affords sufficient depth of focus with minimum distortion.

Adjustments for variable light and weather conditions are made by the photographer, and excellent results are obtained on clear, bright days with an exposure of one twenty-fifth second at f.11. On cloudy or rainy days the maximum exposure is one-fifth second at f.8.

After the selection of a site for taking the pictures the next step was to set a post 44 inches high, on top of which was a brass plate

with a threaded pin in the center. A sister plate on the center of the bottom of the camera gives a smooth bearing surface for the circular movement of the camera. The pin holds the outfit in place, and a set screw is used on windy days to prevent revolving. The height of this post was set at 44 inches because neither of the hip bones of a large cow breaks over the top line when the camera is placed at this level. At this height it is necessary to direct the camera slightly downward in order to center the object.

The plot of ground around the camera was carefully surveyed and leveled; and at a distance of 27 feet 2 inches from the center of the post, a semicircular line of 1-inch boards was placed in the ground on edge, so that the upper edge was flush with the surface of the ground. (Fig. 12.) Another line of boards was similarly placed 18 inches beyond the first. These two lines make a semicircular track, everywhere equidistant from the center of the post on which the camera rests, and consequently any animal standing in this track at any point is always the same distance from the camera lens. As the camera is focused on the plane of the track, which is just wide enough to accommodate the animal, the operator centers the object laterally and "shoots" as soon as the animal is in position. All animals 1 year old or more are taken in this manner.

For animals under 1 year of age, it was found more convenient to do the work closer to the barn; and, in order to make comparisons more readily, a board background laid off in 6-inch squares has been adopted. (Figs. 20 and 22.) These pictures are taken with the same camera and same focal length as the others, and the calves are placed the same distance from the camera. Thus all pictures are taken on the same scale, and comparisons between various animals and between different pictures of the same animal can be equitably made.

POSITION OF THE ANIMAL

Most changes in position are made by shifting a part of the skeletal structure of the animal; and unless all animals are photographed in a standard position, the skeletal points will not always be in the same relation to each other. Only side photographs are used in this work; and to avoid any distortion, the animal is made to stand with her right side directly in front of the camera. The left hind foot is slightly advanced, and the shank of the right hind leg and both fore legs should be vertical and so placed that the left fore leg is slightly visible behind the right. In very young animals the position of the left hind foot should be watched closely, for if the foot is advanced too far the rump goes down. The position adopted is one which is assumed naturally, and the animal is at ease.

The method used in handling the animal is to lead it on the track, and while one man holds the halter the other places the feet in the proper position, relying on the photographer to determine from his place at the camera when the pose is correct. The man at the halter then steps back, and the other man walks around to the right and front of the animal to attract its attention. This brings the head around slightly toward the camera and the ears forward.

A crew in operation is shown in Figure 13. No effort is made to pose the animal to cover up defects, such as a low back, poor

rump, or defective fore udder; such practice would defeat the purpose for which these pictures are taken. The aim is to get as nearly



FIG. 13.—Photographic crew at work. The animal is standing on the track, but this is obscured by the grass

perfect a reproduction of the animal in a natural pose as is possible. Correct position as here defined is best illustrated by the pictures shown. (Figs. 14, 15, 16, 17, 18, and 19.)



FIG. 14.—A good pose of the subject. (See also figs. 15 and 16)

Conspicuous objects in the background draw attention from the subject of the picture; and in like manner the attendant or man at

the halter, if he is not careful, can spoil the effect of a good photograph by being caught in the field of the camera. Quick work on the



FIG. 15.—A good pose of the subject. (See also figs. 14 and 16)

part of the attendants is essential. Many animals will not stand very long in one position, and the photographer needs to be alert to catch the animal in the correct pose and to avoid snapping before the men



FIG. 16.—A good pose of the subject. (See also figs. 14 and 15)

are out of the picture. Patience, especially with young animals, is necessary, but a good picture is usually the reward of care and close watching. (Figs. 20 and 21.)



FIG. 17.—Poor pose. Hind feet are too far under the animal and fore feet are placed too wide apart. (Figures 1, 4, and 10 further illustrate poor poses)

SCHEDULE FOR PICTURES

The present schedule calls for pictures at the ages of 2 weeks, and 1, 2, 3, 4, 5, 6, 9, and 12 months, all taken with the cross-ruled

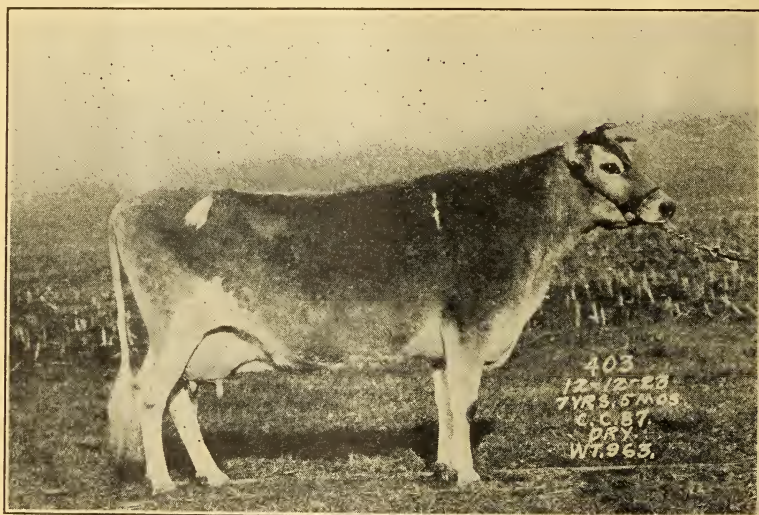


FIG. 18.—A good pose for comparative photography. Compare with figure 19

background. The pictures on the track are taken at 12 months, 18 months, and 2 years. Thereafter the females are photographed just before and after calving at each parturition, and at least once each year.



FIG. 19.—Same animal as in Figure 18 (but at different age). Here shown in poor pose

This may seem like a continuous performance in a large herd of cattle, but an hour or two one afternoon each week is all the time necessary for the young animals. The work on the track is done one



FIG. 20.—A human figure in the picture draws attention from the subject. (See also figures 1, 10, and 21)

day each month, and at that time all animals approaching or just past the specified ages are taken, as well as all cows nearing calving or recently fresh.

LEGENDS

No animal photograph taken for purposes of study would be complete without some necessary information, and legends are placed on the negatives before the pictures are printed. The legend consists of the number of the animal, date when picture was taken, weight of the animal at time picture was taken, age of the animal, number of the dam in the case of a young animal, and for older females the number of days in milk, and number of days pregnant. With this information, the photographic album tells a fairly complete story.

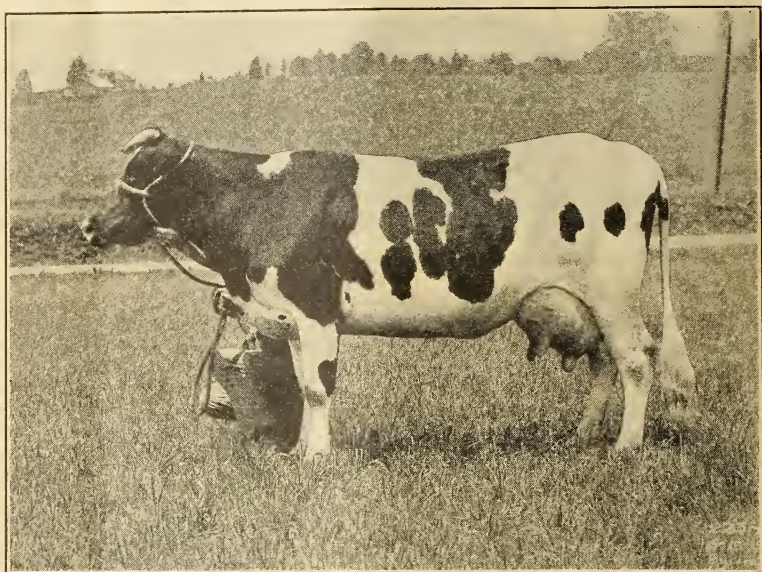


FIG. 21.—A human figure in the picture draws attention from the subject. (See figures 1, 10, and 20)

SOME RESULTS OBTAINED

What has been done is best shown by the pictures taken from the files, and these are but a few examples of things which have come to the attention of the writer during the short time the photographic work has been under way. The legends call attention to the points illustrated.

The work is not yet far enough along to show by pictures the entire life history of any mature cows, but the growing generations of animals at Beltsville are being handled so that there need be no speculation as to their early appearance. Figure 22 is a photograph of one page of the album, and the eight pictures portray the development of heifer 618 to the age of 9 months.

In addition to these serial photographs of single animals, the files contain material for comparative study of all animals in a breeding

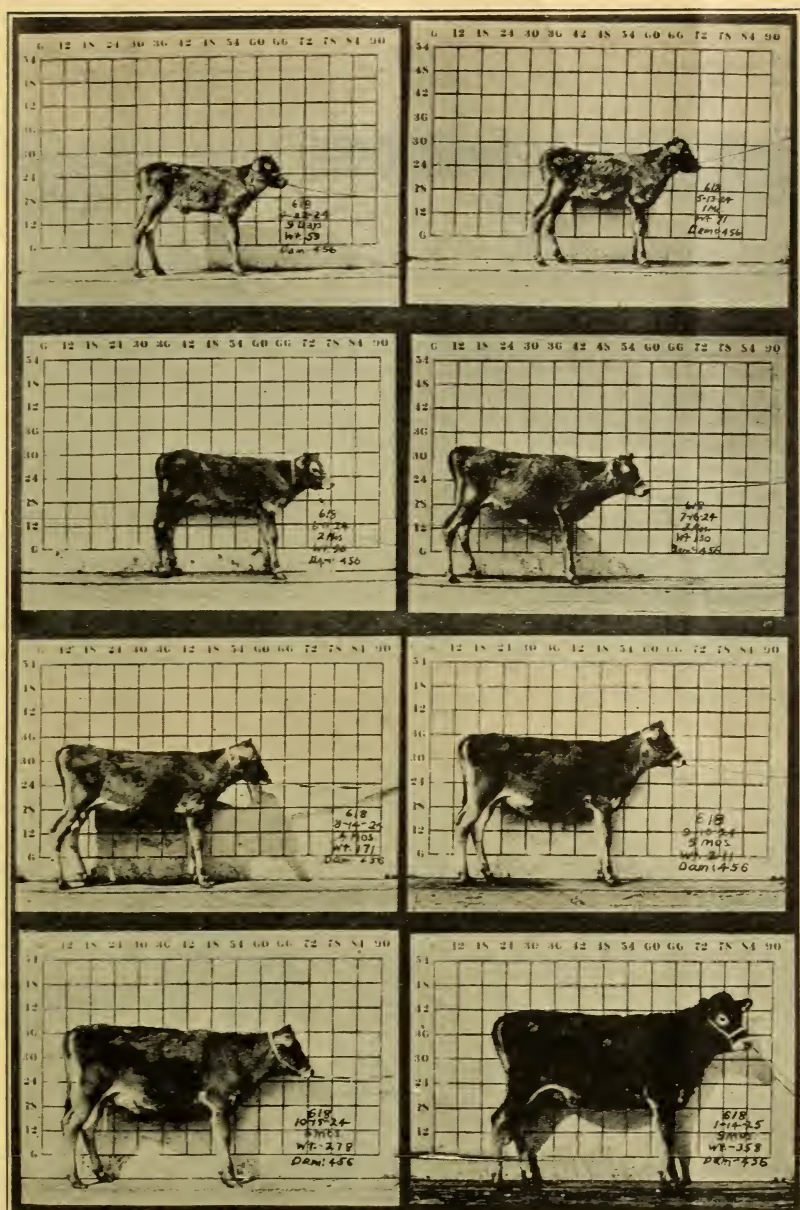


FIG. 22.—Reproduction of eight pictures of heifer 618, showing growth and development to age of 9 months

project at the same age. The appearance of a large number of daughters of each of the herd bulls may be contrasted at any stage of development without making allowances for differences in age.

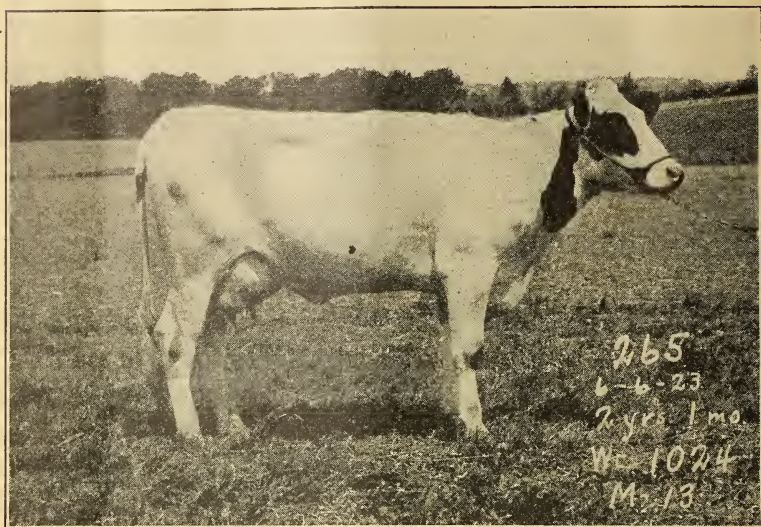


FIG. 23.—Animals 265 and 279 (see figure 24) are full sisters. Each was photographed just after calving at 2 years 1 month of age

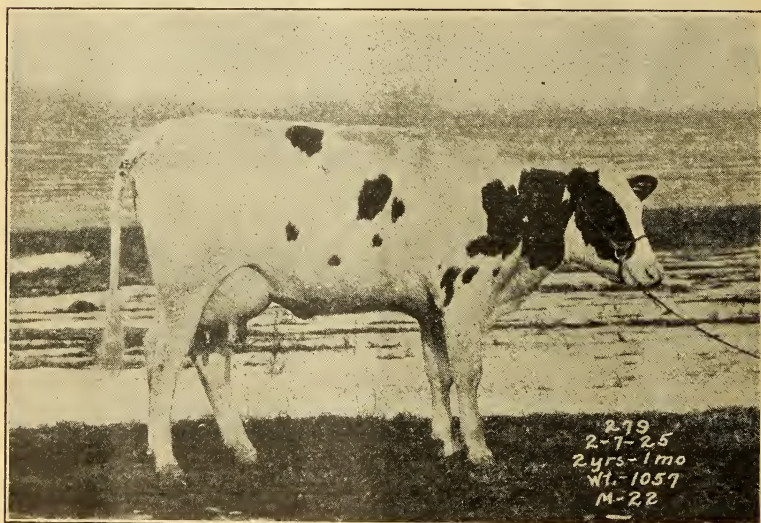


FIG. 24.—Animals 279 and 265 (see figure 23) are full sisters. Each was photographed just after calving at 2 years 1 month of age



FIG. 25.—Animals 287 and 275 (see figure 26) are full sisters photographed at age of 18 months



FIG. 26.—Animals 275 and 287 (see figure 25) are full sisters photographed at age of 18 months

Figures 23 and 24 are of interest because these animals are full sisters, and the pictures show them both shortly after first parturition at 2 years and 1 month of age. The animals shown in Figures 25 and 26 are also full sisters. They show a very striking contrast in gen-



FIG. 27.—Striking change in appearance of same animal during one year. This cow, No. 439, freshened shortly after last picture was taken and produced over 700 pounds of butterfat during succeeding year

eral conformation. Both pictures in this pair were taken when the animals were 18 months old.

Changes which occur in general appearance of animals are permanently recorded by the camera, and Figure 27 shows the trans-

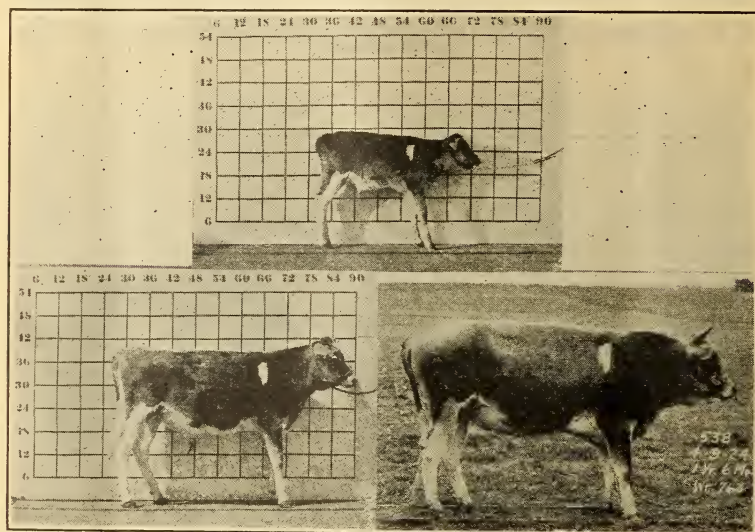


FIG. 28.—Striking changes in angle of the rump. Pictures taken at 1 month, 7 months, and 18 months of age

formation occurring in a single year. This cow freshened shortly after the last picture was taken and produced over 700 pounds of butterfat during the succeeding year.

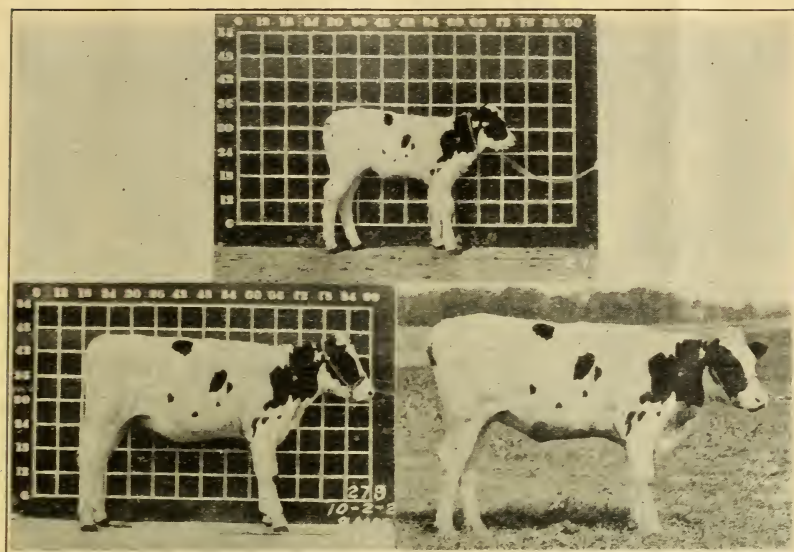


FIG. 29.—Changes in the angle of the rump. Pictures taken at 25 days, 9 months, and 18 months

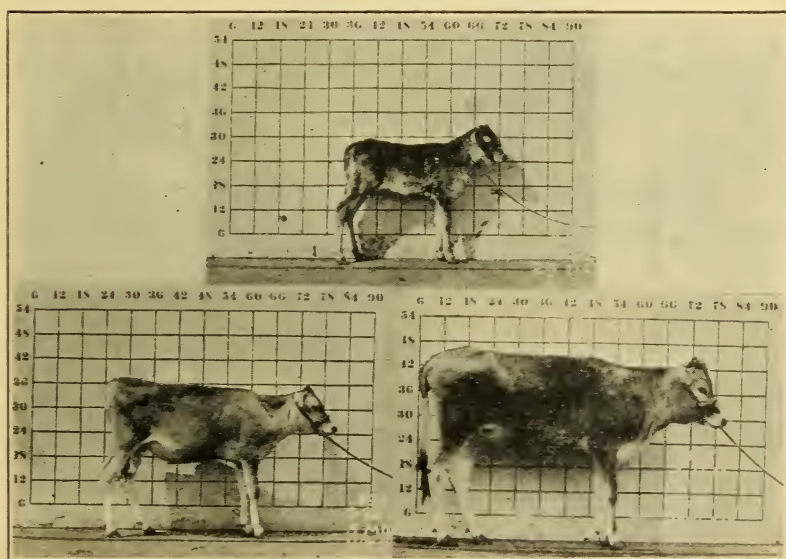


FIG. 30.—Changes in the angle or slope of rump. Pictures taken at 23 days, 5 months, and 12 months of age

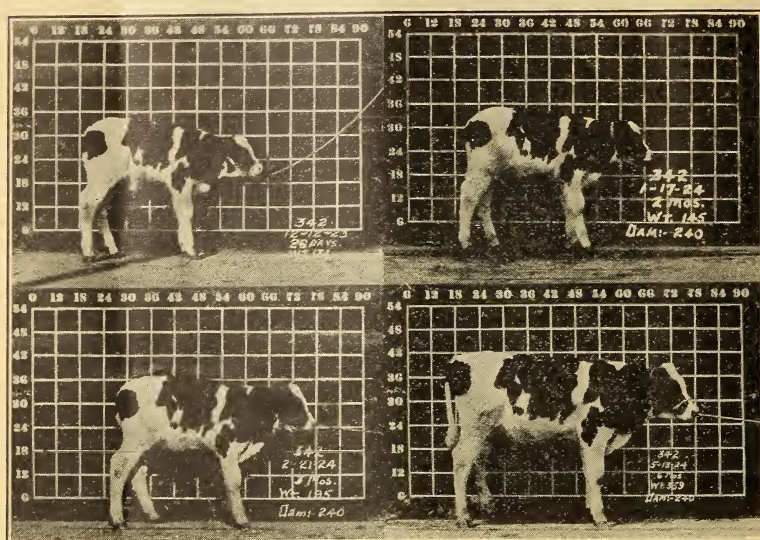


FIG. 31.—Changes in angle or slope of rump. Pictures taken at 26 days, 2 months, 3 months, and 6 months of age

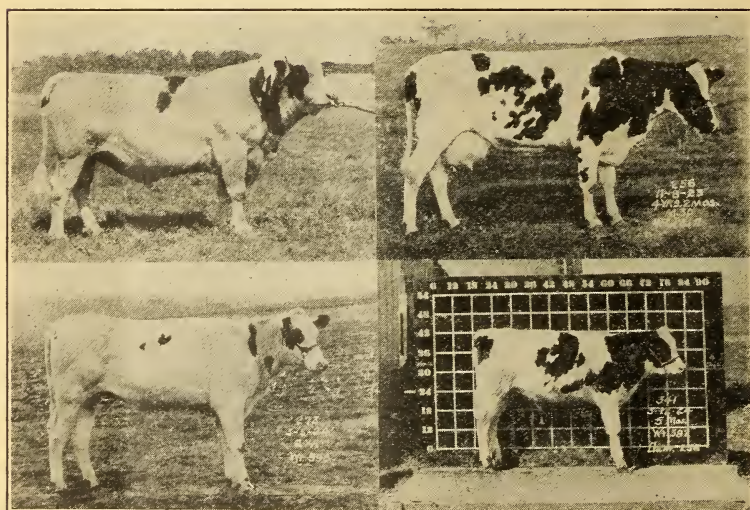


FIG. 32.—Bull 316 and cow 256 shown at top produced heifer 273 and bull 341 shown at bottom. Sire is straight and dam a sloper. In their offspring the heifer slopes and the bull has a level rump

The angle of the rump is a matter of interest to breeders of dairy cattle. Figures 28, 29, 30, and 31 illustrate some of the striking changes in the rump which occur during a few months' time. In Figure 32 this point of rump conformation is shown in two generations. The animals at the top are sire and dam of the lower animals. Note the contrast in parents as well as in offspring.

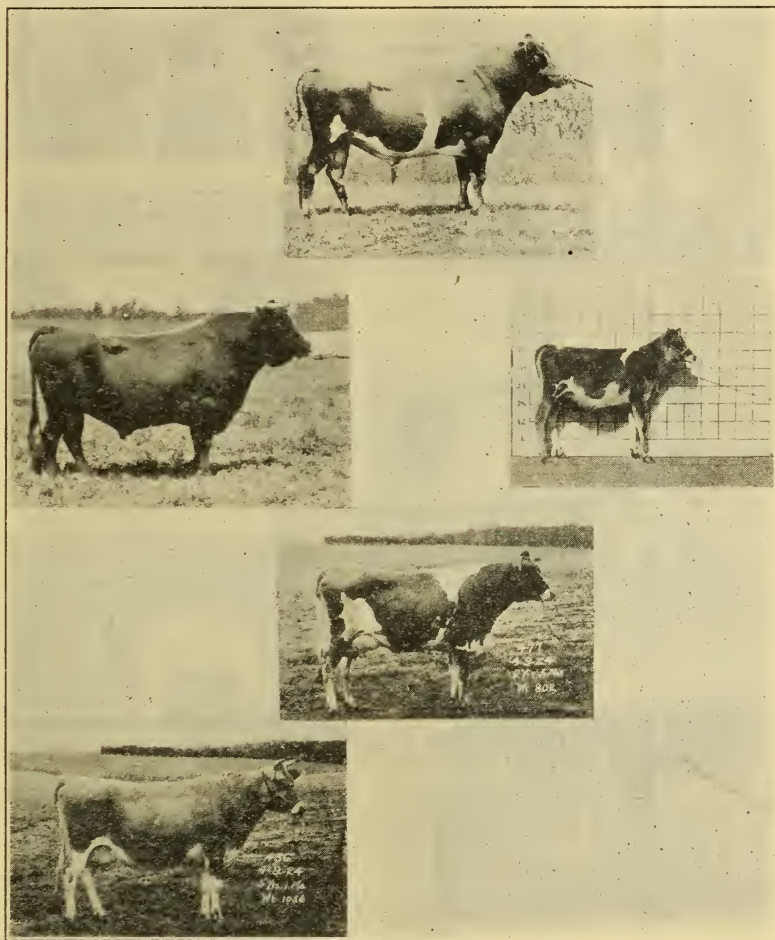


FIG. 33.—How white spotting is transmitted in Jersey cattle

Figure 33 illustrates the inheritance of white spotting in Jersey cattle as a Mendelian recessive. Other material has been assembled and used to illustrate further the manner of inheritance of white spotting.

From the collection of pictures the material was gathered for Figures 34 and 35. They offer some interesting contrasts of color

inheritance in Holstein-Friesian cattle. In Figure 34 are shown two cows of decidedly different proportions of white and black which were mated twice to a bull mostly white. Each cow produced two bull calves distinctly different in appearance so far as

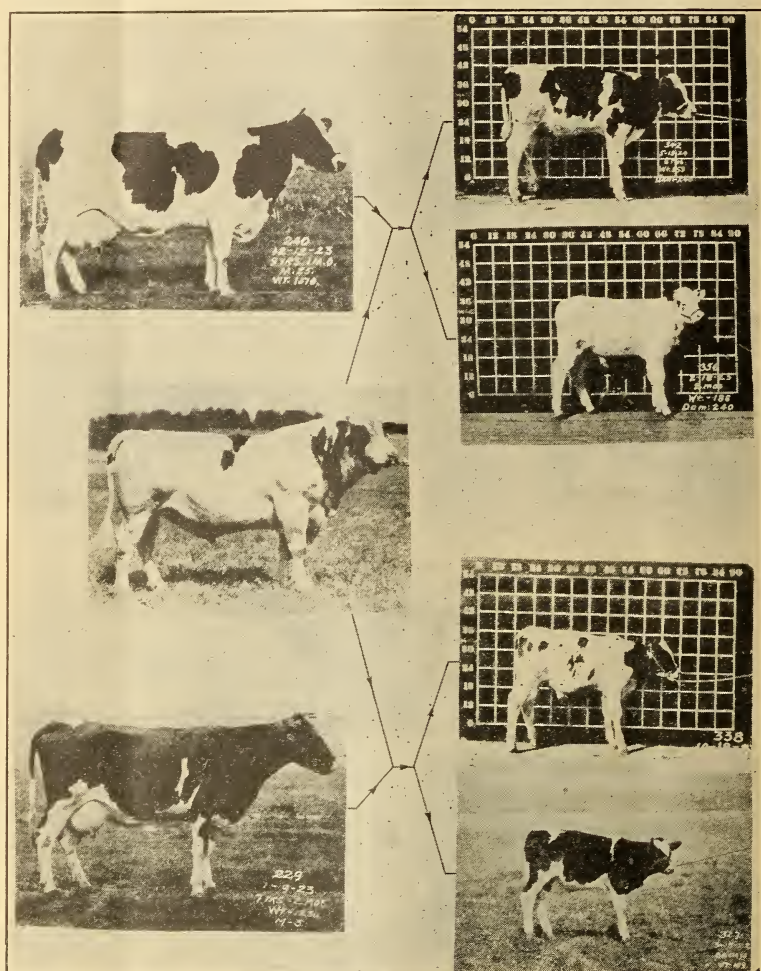


FIG. 34.—Cow 240 mated to the white bull shown in the picture produced two bull calves, one about half black and white, and the other with only a few small black spots. Cow 299 mated to the same bull produced two bull calves, one mostly white and the other mostly black

distribution of color goes. Figure 35 shows a dark cow and a light cow which were mated to a light bull; the dark cow dropped a light-colored heifer, and the light cow produced a dark heifer.

The changes which occur in the appearance of animals, as well as visible hereditary characteristics that may be studied in groups

or through several generations, are being recorded photographically by following the system outlined. Details which appear to be of small moment when the pictures are taken may become of great

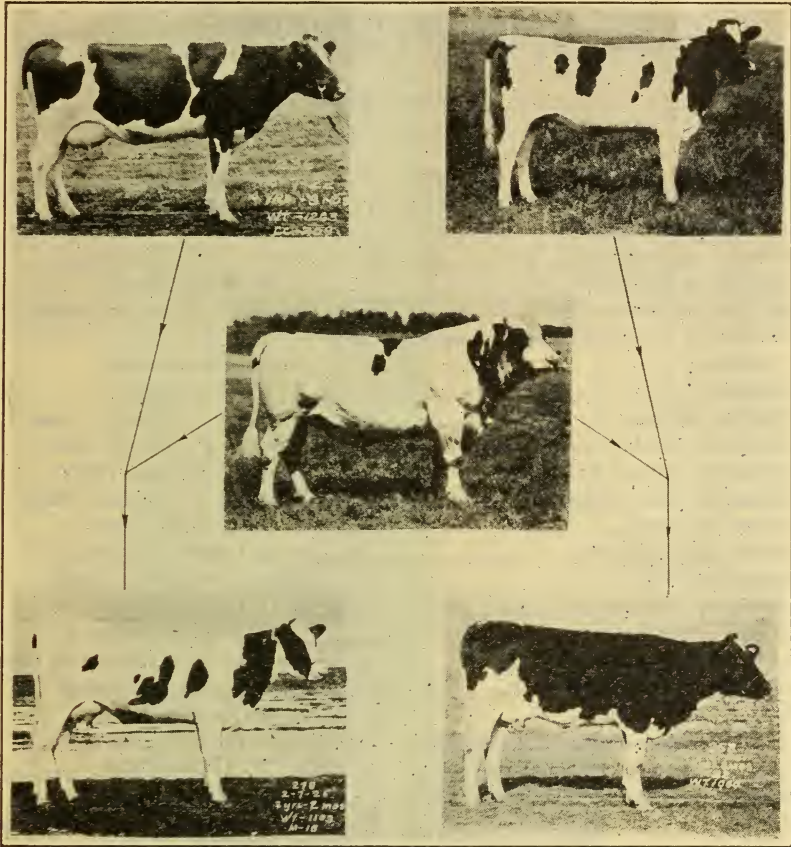


FIG. 35.—Cow 236 mated to the white bull shown in the picture produced heifer 278; cow 253 (upper right corner) mated to the same bull produced heifer 268. No definite indication is given of how the colors are transmitted

importance as time goes on. The photographic record in conjunction with written details will form a permanent history of the work accomplished in the breeding experiments.

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